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## A CHECKING TABLE FOR THE METHOD OF CONSTANT STIMULI<sup>1</sup>

## By GILBERT J. RICH, Hobart College

In the computation of a limen, according to the *phi-gamma* hypothesis, from data obtained by the method of constant stimuli (or the method of constant stimulus differences), one finds for every stimulus (or stimulus difference) employed the five values: P, P, xP, xxP, xxP, xxP, xxP, xxP and  $x \gamma P.^2$  It is then necessary to obtain the sum of each one of these five values for all of the stimuli used, namely: [P], [PP], [xP], [xxP] and [xpP]. It is frequently desirable to check the required additions, which, since both positive and negative quantities occur, are especially liable to error. The simplest procedure for checking, known as 'cross-addition,' consists in finding for every stimulus the total of the five values (a total which we shall designate by the symbol 'T'). If no mistakes have occurred in the additions, the sum of the T-values thus obtained will equal the total of the five sums [P], [PP], [xxP], [xxP] and [x, P].

T-values thus obtained will equal the total of the five sums [F], [FF], [xP], [xxP], and [x P].

But the five values mentioned, which are obtained for every stimulus, depend solely on the x and the p (percentage of judgments) for that particular stimulus. If Urban's tables are used we are limited to 15 possible x's (-7 to 7) and 99 possible p's (.01 to .99). There are, then, only 1,485 possible combinations of p and x, and only that number of possible values of the quantity T under these conditions.

The accompanying checking table contains the values of T just men-

<sup>&</sup>lt;sup>1</sup> From the Department of Psychology, Cornell University.

<sup>&</sup>lt;sup>2</sup> For the general procedure in these computations see: E. B. Titchener, Experimental Psychology, Quantitative Student's Manual, 92 ff., and E. G. Boring, Urban's Tables and the Method of Constant Stimuli, Amer. Jour. Psych., 28, 1917, 280 ff.

<sup>&</sup>lt;sup>3</sup> The method used by Fernberger and by Urban, and described by Boring, op. cit., 288, involves more labor than does mere 'cross addition,' but localizes more closely any possible errors. Its use here, however, would require two tables instead of our one.

however, would require two tables instead of our one.

<sup>4</sup> F. M. Urban, Hilfstabellen für die Konstanzmethode, Arch. f. d. ges. Psych. 24, 1912, 236 ff. and 25, Literaturber, 84; Die Praxis der Konstanzmethode, Leipzig, 1912.

Directions for using these tables will be found in Boring, op. cit.

<sup>&</sup>lt;sup>5</sup> Since  $15 \times 99 = 1,485$ .

<sup>&</sup>lt;sup>6</sup> I am indebted to my former associates in the Cornell Laboratory, Miss J. M. Gleason, Dr. E. G. Boring, Dr. W. S. Foster, Mr. <sup>7</sup>. B. Hoisington, and Mr. H. G Bishop for much valuable assistance in the preparation of this table; and to Miss K. M. Schutt of Ithaca for her careful work in typing the copy reproduced here.

\$\begin{align*}{\text{K}} \text{\$X=-7\$} \text{\$X=-6\$} \text{\$X=-7\$} \text{\$A=-3203} \text{\$3.0080} \text{\$2.0210} \text{\$1.1595} \text{\$5.235} \text{\$1.18} \text{\$1.2525} \text{\$1.2630} \text{\$2.3649} \text{\$1.2631} \text{\$1.0686} \text{\$3.2649} \text{\$1.2630} \text{\$1.2632} \text{\$1.2632} \text{\$2.3649} \text{\$1.2636} \text{\$3.2631} \text{\$1.2632} \text{\$1.2632} \text{\$2.3649} \text{\$1.2632} \text{\$1.2632} \text{\$2.3649} \text{\$1.2632} \text{\$1.2632} \text{\$2.3649} \text{\$1.2632} \text{\$1.2632} \text{\$3.2535} \text{\$1.2632} \text{\$1.2632} \text{\$3.2535} \text{\$1.2632} \text{\$1.2632} \text{\$3.2535} \text{\$1.2632} \text{\$3.2535} \text{\$1.2632} \text{\$3.2535} \text{\$1.2632} \text{\$3.2535} \text{\$3.2632} \text{\$1.2632} \text{\$3.2632} \text{\$3.2632} \text{\$1.2632} \text{\$3.2632}	6	= -5 Y=
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17			1 0866	2.9408 8980 1	6.8796 2.9408 .9980 I	12.8141 6.8796 2.9408 .9980 1	7446 12.8141 6.8796 2.9408 .9980 1
36	7 ~	7 ~	. 9943	2.8946 .9943 1	6.7835 2.8946 8943 1	12.6610 6.7835 2.8946 .9943 1	5271 12.6610 6.7835 2.8946 9943 1
76			. 9918	2.8695 .9918 1	6.7308 2.8695 .9918 1	12.5757 6.7308 2.8695 .9918 1	4041 12.5757 6.7308 2.8695 .9918 1
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59	_	_	.9853 1	2.8154 .9853 1	6.6160 2.8154 .9853 1	12.3873 6.6160 2.8154 .9853 1	1293 12.3873 6.6160 2.8154 .9853 1
93	_	_	.9814	2.7862 .9814 1	6.5537 2.7862 .9814 1	12.2841 6.5537 2.7862 .9814 1	9770 12.2841 6.5537 2.7862 .9814 1
18			.9768	2.7554 .9768 1	6.4876 2.7554 .9768 ]	12,1738 6,4876 2,7554 .9768 1	8135 12.1738 6.4876 2.7554 .9768 1
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61	_	7096	.9607	2.6568 .9607	6.2742 2.6568 .9607	11.8132 6.2742 2.6568 .9607	2736 11.8132 6.2742 2.6568 .9607
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70	ľ	ľ	6020	6 50 50 0500 0	6 0200 5 4 5 6 0300 1	11.0401 0.1140 0.0000 2.04011	8600 11.0401 0.1143 6.0030 1.401 0.040
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40	ľ	ľ	6020	ר פאספ פואי פ	C 6500 8125 0 7733 7	ר סאסא אואא ס הנאז טר	ר סיסט מוצג פ מיהה א פונה סו זיפה
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86	_	_	.8590	2.1863 .8590 ]	5.2315 2.1863 .8590 ]	9.9948 5.2315 2.1863 .8590 ]	4760 9.9948 5.2315 2.1863 .8590 ]
92			.8460	2.1346 .8460	5.1154 2.1346 .8460	9.7880 5.1154 2.1346 .8460	1529 9.7880 5.1154 2.1346 .8460
80	_	_	. 8323	2.0814 .8323 ]	4.9949 2.0814 .8323	9.5732 4.9949 2.0814 .8323	8161 9.5732 4.9949 2.0814 .8323
552			.8179	2.0264 .8179	4.8705 2.0264 .8179	9.3506 4.8705 2.0264 .8179	4661 9.3506 4.8705 2.0264 .8179 ]
0.0			68085	1.9694	4.7414 1.9694 .8025	9.1184 4.7414 1.9694 8025	1006 9.1184 4.7414 1.9694 8025
J. C.			7865	1.9110 .7865 7.696 .	4.6084 1.9110 .7865 7	8.8787 4.6084 1.9110 .7865 1	7221 8.8787 4.6084 1.9110 .7865 J
10	Ϊ	Ϊ	660/	3 136 COCO-1	4.4/00 T.0000 T. 2007 1	8.0237 4.4/00 1.0000 .1090 .	3278 8.0297 4.4.700 1.6300 3.2
202	1	1	7327	1.7239 .7327	4.387.   1.7239   7.327	6.37.0 6.37.1 0.32.4 20.7.2 8 1.020 4.1020 1.7327.1	4.050 6.37.0 4.38.4 5.739 1.7239 1.7327 1.73
9			.7129	1.6578 .7129	4.0282 1.6578 .7129	7.8244 4.0282 1.6578 .7129	0464 7.8244 4.0282 1.6578 .7129
87			.6921	1.5896 .6921	3.8714 1.5896 .6921	7.5373 3.8714 1.5896 .6921	5873 7.5373 3.8714 1.5896 .6921
05			.6697	1.5183 .6697	3.7062 1.5183 .6697	7.2336 3.7062 1.5183 .6697	1004 7.2336 3.7062 1.5183 .6697
00.			.6463	1.4451 .6463	3.5368 1.4451 .6463	6.9211 3.5368 1.4451 .6463	6.9211 3.5368 1.4451 .6463
000			0.400	1.000. C000. L	3.5004 1.5095 .0%15	6.5944 5.5604 1.5695 .6745 .	6.74 6.5944 3.5604 1.5695 6645 6645 6645 6645 6645 6645 6645
60	•••	•••	5673	50000 CT6231	2.4821 1.2049 . 5673	5, 8987 9, 9870 1, 2099 5,5673	0250. 01531 1.0110 0.0500 0.05
47			5376	1.1255 .5376	2,7887 1,1255 5376	5.5568 2.7887 1.1255 .5376	3401 5.5968 2.7887 1.1255 5.5376
22	L	L	5059	1.0381 .5059	2.5821 1.0381 .5059	5.1379 2.5821 1.0381 .5059	7055 5.1379 2.5821 1.0381 .5059
05			4718	9467	2.3650 .9467 .4718	4.7269 2.3650 .9467 .4718	0324 4.7269 2.3650 .9467 .4718
91			.4351	.8512 .4351	2.1376 .8512 .4351	4.2941 2.1376 .8512 .4351	3207 4.2941 2.1376 .8512 .4351
000			.3954	.7515 .3954	1.8982 .7515 .3954	3,8359 1,8982 ,7515 ,3954	5641 3.8359 1.8982 .7515 .3954
112			.3519	.6465 .3519	1.6448 .6465 .3519	3.3470 1.6448 .6465 .3519	7529 3.3470 1.6448 .6465 .3519
95			.3036	.5350 .3036	1.3737 .5350 .3036	2.8195 1.3737 .5350 .3036	8728 2.8195 1.3737 .5350 .3036
.51			.2469	.4122 .2469	1.0711 .4122 .2469	2.2236 1.0711 .4122 .2469	2.2236 1.0711 .4122 .2469
13			.1881	.2913 .1881	1881. 2913 .1881	1.6261 .7705 .2913 .1881	1881.   2162.   5077.   1881   1881
181			7271.	7527 7527	721 727 IRLA	7211. 1527 IRLA. 8800	7211. 1527 IRLA. BAND 0262
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27. 27. 24.

76 77 78 79 80

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62 63 64 65 65

91 18.8761 92 17.4739 94 14.3928 95 12.6762 96 10.8011 97 8.6423 98 6.4503

the T's for every x used by Urban and a single p, while every column

contains the T's for every p and a single x.7

The use of the checking table is simple. After obtaining from Urban's tables the five values required for a given stimulus (or stimulus difference), the T for that stimulus, as determined by its x and p, is read from our table and placed in a sixth column. (Note that T is not the same for p and 1.00—p.) The same procedure is followed for every stimulus involved in the calculation. The sum of this sixth column is found just as the sums of the five other columns. If there are no mistakes in computation, the sum of the T-column will be equal to the sum of the sums of the other five columns. For, since each T is obtained according to the formula,

 $T = P + \gamma P + xP + xxP + x\gamma P,$ 

it follows that

 $[T] = [P] + [\gamma P] + [xP] + [xxP] + [x\gamma P]$ . If, however, the sum of the T-column is not equal to the sum of the other five columns, a mistake has been made. There are two possible sources of error. One possibility is that one or more of the additions is wrong; the other is that an error has been made in copying from either Urban's tables or the checking table. In practice, the writer has found most of his discrepancies to be due to

the latter cause.

In building the checking table, we used Urban's tables as published in *Die Praxis der Konstanzmethode*, 1912, which contains two corrections of the tables as originally published in the *Archiv* (for  $6^2P$  when p=.89 and .90). In the course of our work, another error in Urban's tables (both editions) came to light. The value  $5^2P$  when p=.90 is given as 14.4388 and should be 13.4388. We used the corrected value, and our table will show this discrepancy from either edition of Urban.

<sup>&</sup>lt;sup>7</sup> The values of T were themselves checked by finding the sum of each column in our table. It can readily be shown that the sums of two columns of T, having x's numerically equal but different in sign, differ by 2 [xP]. The columns in our table were required to show this difference as a criterion of correctness.